(12) UK Patent Application (19) GB (11) 2 214 247 (13) A

(43) Date of A publication 31.08.1989

(21) Application No 8825904.9

(22) Date of filing 04.11.1988

(30) Priority data
(31) 137650 (32) 24.12.1987 (33) US

(51) INT CL⁴
F16D 23/06

(52) UK CL (Edition J)
F2C C1A11A3 C1A9 C1E4 C1E7 C1E8
U1S S1820 S2018

(56) Documents cited
None

(58) Field of search
UK CL (Edition J) F2C
INT CL⁴ F16D

(71) Applicant
Ford Motor Company Limited

(Incorporated in the United Kingdom)

Eagle Way, Brentwood, Essex, United Kingdom

(72) Inventor
Donald R Rietsch

(74) Agent and/or Address for Service
A Messulam & Co
24 Broadway, Leigh-on-Sea, Essex, SS9 1BN,
United Kingdom

(54) An automotive transmission with synchronized gear engagement

(57) In an manual automotive transmission, rotation of the input shaft after the neutral clutch disengages it from the engine, is stopped through the operation of a clutch formed integrally with a synchronizer that produces a drive ratio whose gear selector position is located in the same plane as the reverse drive position. The synchronizer includes a reverse cone (136) rotatably supported on a countershaft (96) and a reverse blocker ring (140) supported rotatably on the reverse cone. A synchronizer hub (108) is mounted on the countershaft (96) so that the clutch sleeve (112) is located axially between the synchronised gear and the hub. The sleeve (112) is slidably mounted on a flange (111) that extends axially from the hub(108) so that it can move into engagement with a fifth gear blocker ring (116) and the clutch teeth (114) of the fifth gear wheel (102) or when moved in the opposite axial direction, with the reverse blocker ring (140) to again synchronize gear wheel (102) and shaft (96). The reverse cone (136) is connected by clutch teeth (142, 144) to the gear wheel (102), which is continually in mesh with a gear formed integrally with the input shaft.

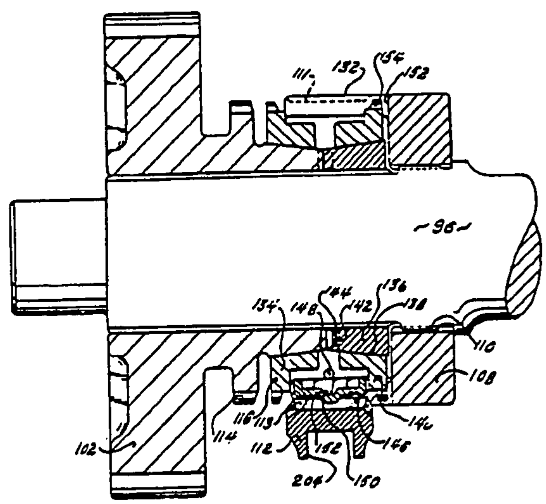
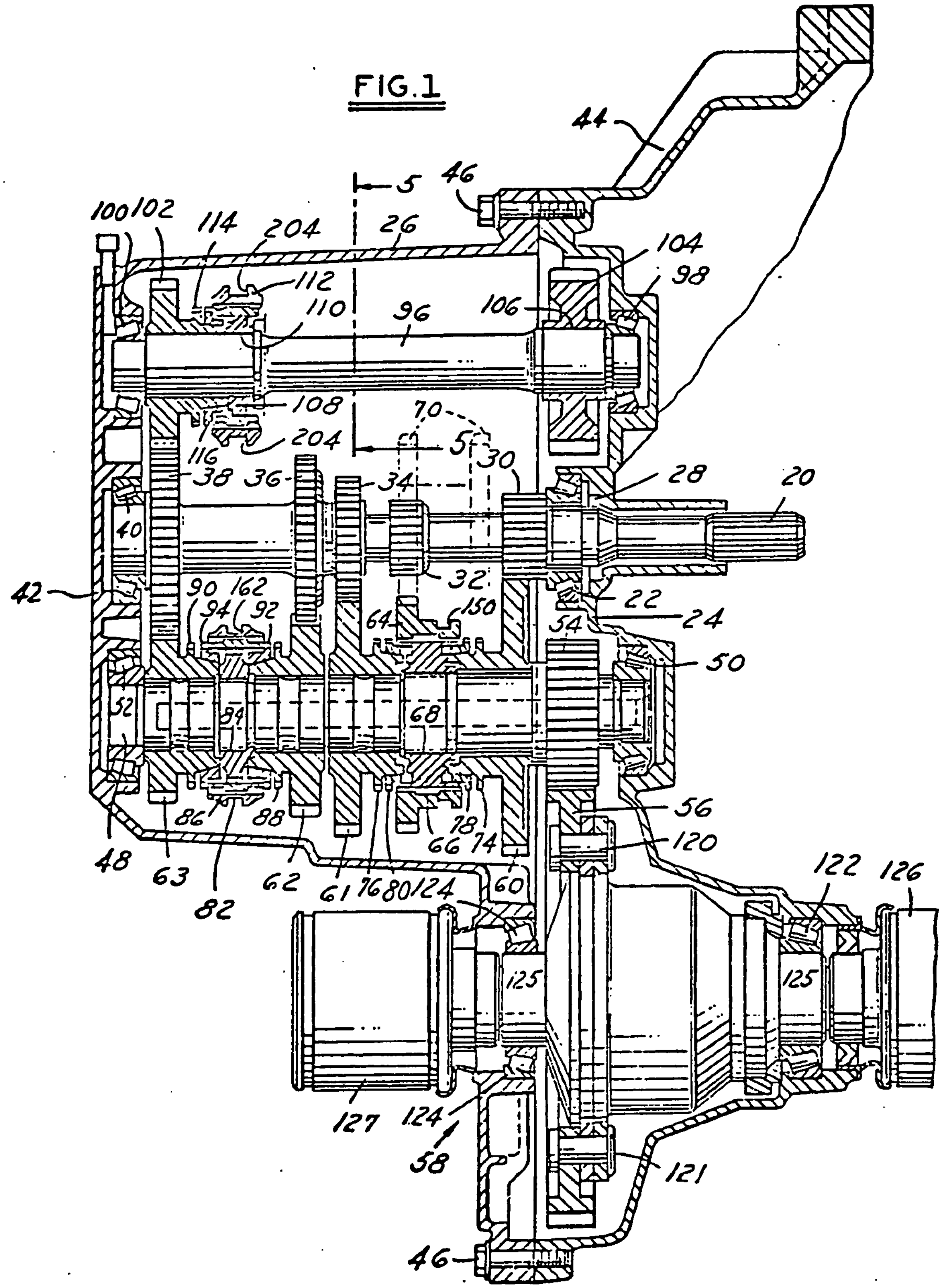


Fig.3

GB 2 214 247

2214247

FIG.1



(

2214247

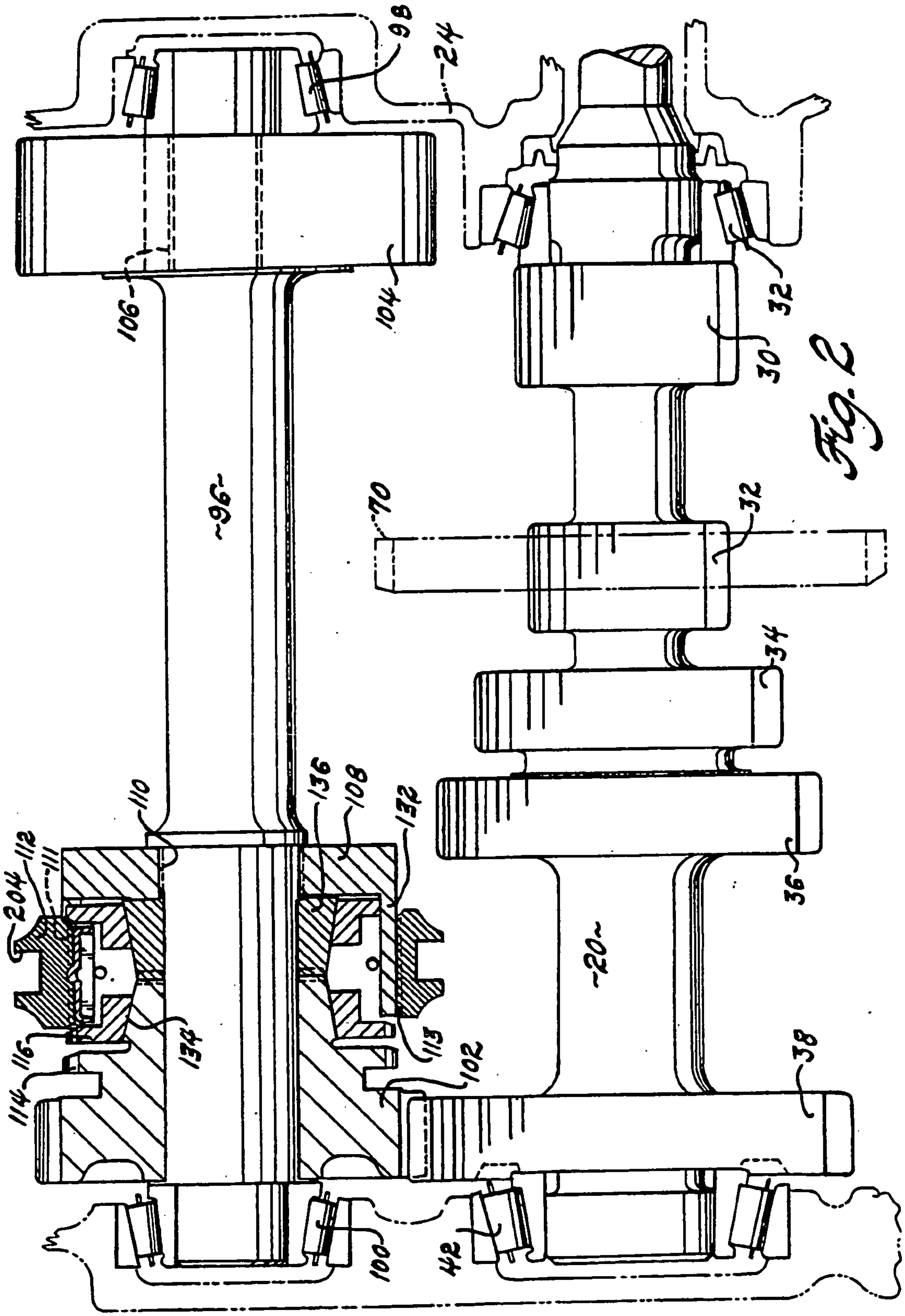


Fig. 2

2214247

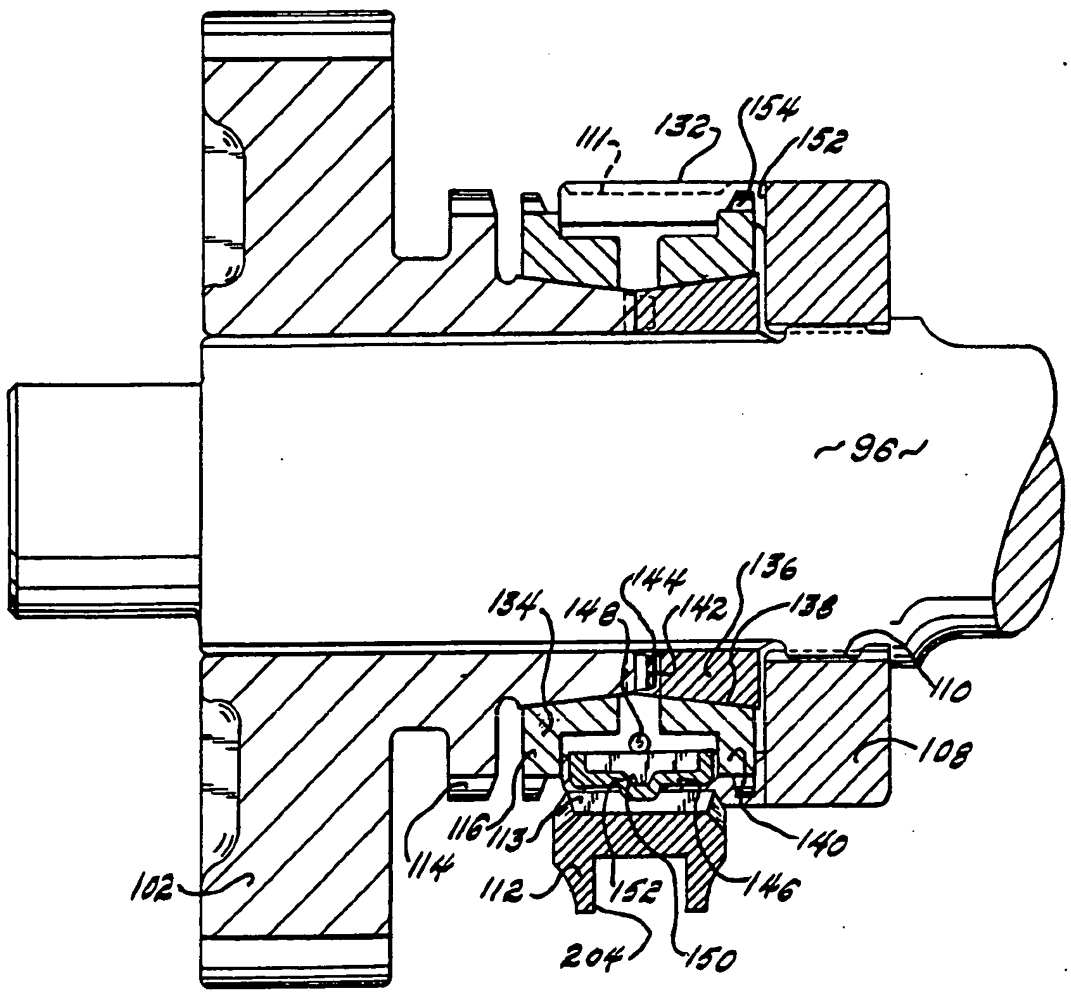


Fig. 3

2214247

AN AUTOMOTIVE TRANSMISSION

This invention generally relates to the field of manually operated automotive transmissions. More particularly, this invention pertains to synchronized gearshift changes in a manual transmission, especially those made in selecting reverse drive.

In the operation of a manual-operated automotive transmission in which reverse drive, or any of the forward drive ratios, is engaged with the use of a sliding gear coupler or another device for connecting a member of the selected gearset to a rotating shaft without first bringing the selected gear and shaft substantially to the same speed before they are drivably connected to each other, the driver must wait several seconds after depressing a neutral clutch to disengage an engine from the gearset before the gearshift lever can be moved to the selected position. A short interval is required to afford adequate time to dissipate, through friction and windage losses, the rotating inertia of the gearset after it is drivably disconnected from the power source. If the gear selector lever is moved to the selected position before the speed of the gear and the shaft are substantially equal or before sufficient rotating energy is dissipated, the teeth of the coupler or synchronizer sleeve will strike the clutch teeth of the member to be engaged. The force applied manually by

the vehicle operator to the coupler or synchronizer sleeve toward the direction of their engagement with the selected gear will cause a loud clash as the tips of the sleeve teeth and those of the dog or clutch teeth are forced together but are unable to mesh because of their relative rotational speeds. The clash is objectionable to most drivers and can, if the forces applied by the operator are large enough, damage the clutch teeth or those of the sleeve.

An obvious technique to avoid this difficulty is to provide fully synchronized gear engagement. This approach has been adopted throughout the automotive industry with respect to all of the forward drive ratios including the lowest speed ratio. However, the cost and complexity to synchronize the reverse drive engagement has not been fully justified commercially, particularly in view of the limited need for reverse synchronized engagement. Generally, it can be assumed that reverse drive is selected when the vehicle is operating at low speed or when the drive wheels are fully stopped through operation of the wheel brakes. Furthermore, the delay between the time when the neutral clutch pedal is depressed to disengage the engine from the gearset and the time when the selector lever can be moved to the reverse drive position without producing clash is acceptable, though longer than the period required for this action between gear shifts in the forward drive ratios while the vehicle is accelerating or traveling at high speed.

Nonetheless, any delay after the neutral clutch pedal is depressed and before the shift lever can be moved to the reverse drive position to avoid causing clash is objectionable, particularly so in a small vehicle where high speed engines and manual transmissions are often used. Even at the idle speed of small modern

engines, the gearset when driven by the engine turns at a high speed, has inherently high inertia and requires longer periods of delay before the reverse drive or any unsynchronized gear shift can be completed.

The device according to this invention is employed in a transmission having at least one drive ratio produced with a sliding gear coupler, or other unsynchronized technique, and wherein that drive ratio is located in a common gearshift plane with another drive ratio whose engagement is made synchronously. The sleeve of the synchronizer that drivably engages the gear ratio located in the same plane as the unsynchronized gear ratio is moved axially along the shaft on which it is supported toward the corresponding gear wheel to make the synchronized engagement, and away from that gear wheel when the selector shaft is moved in the direction that produces the synchronized gearing engagement. Therefore, there is a neutral position between the extremities of the gear selector movement where neither of the gear ratios is engaged and where the operator depresses the neutral clutch prior to engaging either of the gear ratios located in the shift plane.

The synchronizer of this invention includes a braking mechanism for stopping rotation of a gear wheel that is not a member of the selected gearset and whose engagement when a member of a selected gearset is made synchronously by movement of the synchronizer sleeve from the neutral position toward the gear wheel. The gear wheel is continually engaged with an input cluster shaft that is drivably connected to the engine through a neutral clutch, whose engaged and disengaged state is determined by manual operation by the vehicle operator of

a clutch pedal. In this way, after the neutral clutch is depressed, the input shaft inertia is dissipated by brake friction through operation of the synchronizer brake until the gear wheel is stopped. The cluster gear includes multiple input pinions each of which are continually engaged with output gears carried on a countershaft. The output gears are drivably connected to the countershaft through conventional synchronizer clutches whose sleeves are moved to produce a connection between the countershaft and the selected gear as the vehicle operator manually moves the selector lever between the various gear ratio positions. The output gears are rotatably supported on their countershaft, but the gears are merely journalled on the countershaft and connected drivably to it through operation of the associated synchronizer clutches.

The gearset brake according to this invention includes a brake surface formed on a fifth speed gear; a reverse brake surface supported on a countershaft clutched to the gear; blocker rings, each supported on a brake surface; a synchronizer hub connected to the countershaft; a sleeve slidably supported on the hub and drivably engaging the gear and the blocker rings; and spring biased struts. The sleeve, brake surfaces, blocker rings and struts are located on the countershaft between the gear and the hub of the synchronizer.

The sleeve moves along the countershaft in both axial directions from a neutral position depending on the direction the gear selector lever is moved by the vehicle operator. When the selected gear ratio requires the adjacent gear to be used in the drivetrain, the gear is synchronized in the conventional manner before the sleeve drivably connects the countershaft and gear. However, when a sliding gear is to be used in the drivetrain, the sleeve moves away from the adjacent gear and forces the

associated blocker ring to engage the corresponding brake surface, which is clutched to the gear. In this way, the input shaft, which is continually meshing with the gear, is synchronized with the speed of the countershaft in the process of making the selected gear ratio change. This action causes the reverse input gear on the input shaft to have the same speed as that of the drive wheels, which are continually connected to the countershaft through the differential mechanism. Therefore, the sliding gear can mesh without delay or interference with the reverse input gear and reverse output gear because the drive wheels will be substantially stopped before the reverse drive ratio is selected.

The reverse spin down brake of this invention includes simple brake components, blocker rings and the conventional components of a synchronizer clutch sleeve and a synchronizer hub which differs from conventional hubs only with respect to its location and the use of a flange to support the sleeve.

The invention will now be described further by way of example, with reference to the accompanying drawings in which:

Figure 1 is a cross section through a multiple countershaft manual transmission and the differential mechanism with which the gearset brake according to this invention can be used.

Figure 2 is a cross section through the axis of the auxiliary countershaft and the input shaft of the transmission of Figure 1, showing in greater detail than Figure 1 the gearset brake according to this invention.

Figure 3 is a cross section through the synchronizer clutch and gear wheel of Figure 2.

Referring first to Figure 1, an input shaft assembly 20 is journalled in a bearing 22 mounted in the support wall 24 of the transmission housing 26. The shaft seal 28, located in an annular recess formed in the support wall 24, seals the outer periphery of shaft 20.

Formed on or carried by shaft 20 are five torque input gears shown respectively at 30, 32, 34, 36 and 38. These gears form torque delivery paths during operation in low speed ratio, reverse, second speed ratio, third speed ratio and fourth speed ratio, respectively. Drive gear 38 further operates to provide a portion of the torque delivery path for the fifth speed ratio. The left end of the input shaft is journalled by bearing 40 in a bearing opening formed in the end wall 42 of the housing 26. The right-hand end of the housing is bolted to the left-hand end of the clutch housing 44 as indicated by the attachment bolt 46.

A countershaft 48 is journalled at one axial end in bearing 50, which is received in a recess formed in wall 24, and at the opposite end in bearing 52, which is received in a recess formed in the end wall 42. Output gear 54 is fixed to or integrally formed with countershaft 48 and meshes with the output gear 56, which drives a differential gear assembly designated generally by the reference character 58. The countershaft supports pinions 60-63, each forming a part of the torque delivery paths for low speed ratio, second speed ratio, third speed ratio and fourth speed ratio. The pinions are journalled on the outer surface of the countershaft.

A reverse gear 64 is formed integrally with the sleeve of synchronizer clutch 66, which is splined at 68 to the countershaft 48. A reverse drive idler 70, which moves between the extremities of its range shown in

Figure 1, meshes with the teeth of the reverse input gear 32 and the reverse pinion 64 when it is moved into alignment with those gears.

Reverse gear 64 has internal clutch teeth adapted to engage dog teeth 74, 76 formed respectively on the hubs of output gear wheels 60 and 61. Synchronizer rings 78, 80 act to synchronize the speed of the reverse gear 64 with the speed of pinions 60 or 61 before engaging the associated dog teeth of the pinion. In this way the pinions are drivably connected through the synchronizer hub to countershaft 48.

When the reverse idler is aligned with gear 32 and reverse pinion 64, a reverse torque delivery path is completed between the input shaft 20 and the output gear 54. When operating the transmission in any ratio except reverse ratio, reverse idler 70 is located at the right-hand end of its range of motion.

A three-four synchronizer clutch 82 is splined at 84 to countershaft 48 and carries external splines on which an internally splined clutch sleeve 86 is slidably mounted. Sleeve 86 has internal clutch teeth adapted to engage dog teeth 88, 90 formed respectively on the hubs of pinions 62 and 63. The synchronizer clutch rings 92, 94, located between hub 82 and pinions 62, 63, establish speed synchronism between the countershaft and the selected gear in accordance with the direction that clutch sleeve 86 is moved.

An auxiliary countershaft 96 is rotatably supported by bearings 98 and 100 on the walls of the clutch housing and transmission casing, respectively. The fifth speed ratio pinion 102 is journalled on the outer surface of countershaft 96 and is in continuous meshing engagement with input gear 38 as is fourth speed pinion 63. A fifth speed output gear 104 is splined at 106 to countershaft 96 and is in continuous meshing

engagement with output gear 56. Located between pinion 102 and gear 104, a third synchronizer clutch hub 108 is splined at 110 to the countershaft. The hub has external splines 111 on which an internally splined clutch sleeve 112 is mounted. The sleeve is formed with internal clutch teeth 113 adapted to engage external dog teeth 114 on the hub of the fifth speed pinion 102. A synchronizer blocker ring 116, located between the dog teeth and the clutch hub, establishes synchronism between countershaft 96 and pinion 102.

The differential gear assembly 58 includes output gear 56, which is riveted to flange formed on the differential assembly at 120, 121. The differential is journalled at one end by the bearing 122, which is received in an annular recess formed in the end wall 24, and at the opposite axial end by the bearing 124, which is received in an annular recess formed in the transmission housing 26. Bevel gears mounted on the driveshafts transmit engine torque to each of two constant velocity universal joints 126, 127, through which power is transmitted to each of the forward wheels of the vehicle.

Referring to Figure 2, the hub 108 of the fifth gear synchronizer extends radially outward from its spline connection 110 to auxiliary countershaft 96. It supports sleeve 112 on an integral axially directed flange 132. The fifth speed gear wheel defines a conical surface 134 on which blocker ring 116 is supported. The synchronizer includes a reverse drive cone 136, which defines a conical surface 138 on which reverse blocker ring 140 is supported on the opposite side of the sleeve from the location of blocker ring 116. Cone 136 is drivably connected by clutch teeth 142, which mesh with clutch teeth 144 located on the face of the gear wheel that is adjacent ring 136. The synchronizer struts 146,

which encircle shaft 96 and extend angularly about 120° each, are biased radially outward by springs 148 into an annular detent recess 150 formed on the inner surface of the sleeve. The outer surface of flange 132 has spline teeth which mesh with spline teeth 113 formed on the inner surface of the sleeve.

Flange 132 is formed with axially directed clearance slots 152 spaced angularly about the axis of shaft 96 at approximately 120° intervals. The slots extend circumferentially at these angular locations sufficiently far to permit approximately three teeth 154 located on the periphery of the reverse blocker ring to extend into each slot for engagement with the spline teeth 113 formed on the inner surface of sleeve 112. The clearance slots extend axially sufficiently to permit the sleeve to engage the reverse blocker ring teeth without obstruction. The fifth gear and reverse cones 134, 138 and the blocker rings 116, 140 are located on the same side of the synchronizer hub 108.

In operation, as the vehicle operator moves the selector lever from the neutral position within the fifth speed-reverse drive shift plane to the fifth speed position, sleeve 112 and strut 146 move axially toward the fifth gear 102 until the strut contacts blocker ring 116 and the bump 152, located on the outer surface of the strut, contacts the detent recess on the sleeve. Next, the struts ride out of the detent grooves as the sleeve is moved further toward ring 116. Cone clutch 116 is energized by the force on the struts and sleeve, thereby causing blocker ring 116 to engage the conical surface 134 on the fifth gear. This action brings the rotational speed of the ring gear to the rotational speed of the sleeve and hub, and permits teeth on the sleeve to engage the teeth on the outer periphery of the blocker ring. Then, as the sleeve is moved further toward gear 102, the

sleeve teeth 113 engage teeth 114 and the fifth gear is drivably connected to shaft 96.

When the vehicle operator moves the selector lever from the neutral position to the reverse drive position, the sleeve is moved rightward toward the reverse blocker ring and hub 108. When this occurs, struts 146 contact blocker ring 140 and force ring 140 to engage conical surface 134 on cone 136. This action synchronizes the rotational speed of the fifth gear to that of the auxiliary shaft 196 by way of the driving connection that includes spline 110, hub 108, sleeve 112, blocker ring 140, reverse cone 136, clutch teeth 142, 144 and gear 102. The fifth gear is continually engaged with input gear 138 located on input shaft 20. The output gear 106 is directly connected through output gear 56 and the differential mechanism 58 to the drive wheels of the vehicle. The neutral clutch will have been disengaged manually by the vehicle operator so that input shaft 20 is disconnected from the engine. Therefore, reverse idler 70 can be moved axially along the axis of the input shaft into engagement with reverse pinion 32 and the reverse output gear formed on the periphery of synchronizer sleeve 64 without delay or interference. There is no need in a manual transmission operated with this invention for a period following the disengagement of the neutral clutch to allow time for the rotational inertia of the input shaft to dissipate after it is drivably disconnected from the engine and to slow or stop before the reverse idler 70 can engage input pinion 32. The actuation of the reverse idler and the shaft mechanism is described in U.S. Serial No. 299,905, filed September 8, 1981, the entire disclosure which is herein incorporated by reference.

CLAIMS

1. In a transmission, a device for synchronizing and connecting components of the transmission,. comprising:

a first gear;

a second gear having a first brake and clutch means engageable by the clutch surface of the shift control means, drivably connected to the first gear, and rotatably supported on a first shaft;

shift control means movable along the axis of the first shaft from a neutral position in a first direction and in a second direction opposite the first direction, drivably connected to the first shaft and having a clutch surface thereon;

first means including a first blocker ring supported on the first brake and movable against the first brake for drivably connecting and synchronizing the rotational speeds of the second gear and the first shaft in response to movement of said shift control means in said first direction; and

second means including a second brake drivably connected to the second gear, a second blocker ring supported on the second brake and movable against the second brake for synchronizing the rotational speeds of the second gear and the first shaft in response to movement of said shift control means in said second direction without drivably connecting the second gear and first shaft.

2. In a transmission, a device for synchronizing and connecting components of the transmission, comprising:

a first gear;

the second gear drivably connected to the first gear and rotatably supported on a first shaft;

shift control means movable along the axis of the first shaft from a neutral position in a first

direction and in a second direction opposite the first direction;

first and second brakes drivably connected to the second gear;

first and second blocker ring means supported on the first and second brakes movable against the brake surfaces for synchronizing the rotational speeds of the first and second blocker ring means with that of the second gear; and

means for forcing the first and second blocker ring means against the corresponding brake surfaces in response to movement of the shift control means in the first and second directions, respectively.

3. The device of claim 1 wherein:

the shift control means includes a sleeve;

the second blocker ring includes clutch teeth located at its periphery, driveable engageable by the sleeve; and

the second means includes:

a hub fixed to the first shaft having the first and second brakes and the first and second blocker rings located between the second gear and the hub, a flange that extends toward the second gear and supports the sleeve thereon and having a clearance formed in the flange within which clearance the clutch teeth of the second blocker ring are located to permit engagement by the sleeve.

4. The device of claim 3 wherein the second blocker ring has multiple groups of clutch teeth spaced angularly about the axis of the first shaft, and the flange includes multiple clearances within each of which a group of the clutch teeth of the second blocker ring are located to permit engagement by the sleeve.

5. The device of claim 1 further comprising a third gear rotatable mounted on a second shaft and slidable along said second shaft into meshing engagement with the first gear.

6. The device of claim 1 wherein the transmission drives a motor vehicle and further comprising means for drivably connecting the first shaft and the shafts that transmit power to the drive wheels of the vehicle.

7. The device of claim 1 wherein the first and second brakes include clutch teeth, continually and mutually drivably connected.

8. The device of claim 7 wherein:

the shift control means includes a sleeve;

the second blocker ring includes clutch teeth located at its periphery, driveable engageable by the sleeve; and

the second means includes:

a hub fixed to the first shaft having the first and second brakes and the first and second blocker rings located between the second gear and the hub, a flange that extends toward the second gear and supports the sleeve thereon and having a clearance formed in the flange within which clearance the clutch teeth of the second blocker ring are located to permit engagement by the sleeve.

9. The device of claim 8 wherein the second blocker ring has multiple groups of clutch teeth spaced angularly about the axis of the first shaft, and the flange includes multiple clearances within each of which a group of the clutch teeth of the second blocker ring are located to permit engagement by the sleeve.

10. The device of claim 1 further comprising a third gear rotatable mounted on a second shaft and slidable along said second shaft into meshing engagement with the first gear.

11. The device of claim 2 wherein:

the shift control means includes a sleeve;

the second blocker ring means includes clutch teeth located at its periphery, driveable engageable by the sleeve; and

the forcing means includes:

a hub fixed to the first shaft having the first and second brakes and the first and second blocker rings located between the second gear and the hub, a flange that extends toward the second gear and supports the sleeve thereon and having a clearance formed in the flange within which clearance the clutch teeth of the second blocker ring are located to permit engagement by the sleeve.

12. The device of claim 11 wherein the second blocker ring means has multiple groups of clutch teeth spaced angularly about the axis of the first shaft, and the flange includes multiple clearances within each of which a group of the clutch teeth of the second blocker ring are located to permit engagement by the sleeve.

13. The device of claim 2 further comprising a third gear rotatable mounted on a second shaft and slidable along said second shaft into meshing engagement with the first gear.

14. The device of claim 2 wherein the transmission drives a motor vehicle and further comprising means for drivably connecting the first shaft and the shafts that transmit power to the drive wheels of the vehicle.

15. The device of claim 2 wherein the first and second brakes include clutch teeth, continually and mutually drivably connected.

16. The device of claim 15 wherein:

the shift control means includes a sleeve;

the second blocker ring includes clutch teeth located at its periphery, driveable engageable by the sleeve; and

the forcing means includes:

a hub fixed to the first shaft having the first and second brakes and the first and second blocker ring means located between the second gear and the hub, a flange that extends toward the second gear and supports the sleeve thereon and having a clearance formed in the flange within which clearance the clutch teeth of the second blocker ring means are located to permit engagement by the sleeve.

17. The device of claim 16 wherein the second blocker ring means has multiple groups of clutch teeth spaced angularly about the axis of the first shaft, and the flange includes multiple clearances within each of which a group of the clutch teeth of the second blocker ring are located to permit engagement by the sleeve.

18. The device of claim 2 further comprising a third gear rotatable mounted on a second shaft and slidable along said second shaft into meshing engagement with the first gear.

19. An automobile transmission substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.